



Replacement Claims

WHAT IS CLAIMED IS:

1. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface having a plurality of bond pads located thereon, a second surface, and a first bonding element connecting the bond pads to the terminal pads on the substrate; and

a second die comprising a first surface, a second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; the second surface comprising a recessed edge portion along the perimeter of the die; the second die disposed on the first surface of the first die with the bond pads on the first die positioned within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.

2. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate; the first die comprising an active surface having a plurality of bond pads located thereon, an opposing inactive surface, and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die comprising an active surface, an opposing inactive surface, and a perimeter; the active surface having a plurality of bond pads located thereon; the inactive surface having a recessed edge portion along the perimeter of the die; the second die disposed on the active surface of the first die with the recessed edge portion providing an opening over the bond pads of the first die, the opening sufficient for passage of the first bonding element therethrough.

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3. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a surface having terminal pads located thereon;

a first die disposed on said surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, a second surface, and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; the second surface having a thickness removed along the perimeter of the die to provide a recessed edge portion; the second die disposed on the first surface of the first die with the bond pads of the first die located within the recessed edge portion; the recessed edge portion having a sufficient height for clearance of the first bonding element extending from the bond pads on the first die.

4. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a surface having a plurality of terminal pads located thereon;

a first die disposed on said surface of the substrate; the first die comprising a first side having a plurality of bond pads located thereon, an opposing second side, and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die comprising a first side, an opposing second side, and a perimeter; the first side having a plurality of bond pads located thereon; the second side comprising a recessed edge portion along the perimeter of the die; the second die disposed on the first side of the first die with the bond pads of the first die located within the recessed edge portion of the second die, the recessed edge portion having a height sufficient for passage of the first bonding element from the bond pads of the first die therethrough.

5. The die assembly of Claim 4, further comprising: a second bonding element connecting the bond pads of the second die to the terminal pads on the substrate.

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6. The die assembly of Claim 4, further comprising: at least one of an adhesive element disposed between the first die and the substrate, and an adhesive element disposed between the second die and the first die.
7. The die assembly of Claim 6, wherein the adhesive element comprises a die attach adhesive.
8. The die assembly of Claim 6, wherein the adhesive element comprises a tape adhesive.
9. The die assembly of Claim 4, wherein the second die has at least one of a length and a width greater than the first die.
10. The die assembly of Claim 4, wherein the bonding element comprises a TAB tape.
11. The die assembly of Claim 4, wherein the bonding element comprises a wire bond.
12. The die assembly of Claim 4, wherein the substrate comprises a material selected from the group consisting of bismaleimide triazine resin, epoxy resins, ceramics, and polyimide resins.
13. The die assembly of Claim 4, wherein the substrate comprises a metal leadframe.
14. The die assembly of Claim 4, being at least partially encapsulated.
15. A stacked die assembly, comprising:
at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having a plurality of terminal pads located thereon, and a second surface;

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a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein; and

a second die at least partially disposed within the recess of the first die.

16. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having a plurality of terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate through a flip chip attachment, and comprising a first surface and a second surface comprising a recess; and

a second die at least partially disposed within the recess of the first die.

17. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having a plurality of terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate through a flip chip attachment, and comprising a first surface and a second surface comprising a recess; and

a second die at least partially disposed within the recess of the first die; the second die comprising a first side having a plurality of bond pads located thereon; and an opposing second side disposed on the first die.

18. The die assembly of Claim 17, further comprising: a bonding element connecting the bond pads of the second die to the terminal pads on the substrate.

19. The die assembly of Claim 18, wherein the bonding element comprises one of a wire bond and a TAB tape.

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20. The die assembly of Claim 17, further comprising: an adhesive element disposed within the recess between the second die and the first die.
21. The die assembly of Claim 17, wherein the adhesive element comprises one of a die attach adhesive, and a tape adhesive.
22. The die assembly of Claim 17, being at least partially encapsulated.
23. A stacked die assembly, comprising:
a plurality of semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;
a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein; and
a second die at least partially disposed in the recess of the first die; and
a third die disposed on the second die.
24. A stacked die assembly, comprising:
a plurality of semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;
a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein; and
a second die at least partially disposed in the recess of the first die, and comprising a first surface having a plurality of bond pads located thereon, an opposing second surface disposed on the first die, and a bonding element connecting the bond pads of the second die to the terminal pads on the substrate; and
a third die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; and the second surface

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comprising a recessed edge portion along the perimeter; the second surface of the third die disposed on the first surface of the second die whereby the recessed edge portion provides sufficient clearance for the first bonding element extending from the bond pads of the second die.

25. A stacked die assembly, comprising:

a plurality of semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die comprising a first surface disposed on the first surface of the substrate in a flip chip attachment, and a second surface having a recess, the recess having a surface; and

a second die at least partially disposed in the recess of the first die, and comprising a first surface having a plurality of bond pads located thereon, an opposing second surface disposed on the surface of the recess, and a first bonding element connecting the bond pads of the second die to the terminal pads on the substrate; and

a third die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; and the second surface comprising a recessed edge portion along the perimeter; the second surface disposed on the first surface of the second die whereby the recessed edge portion provides sufficient clearance for the first bonding element extending from the bond pads of the second die.

26. The die assembly of Claim 25, wherein the recess in the first die is substantially square or rectangular shaped.

27. The die assembly of Claim 25, wherein the recess in the first die is substantially oval or circular shaped.

28. The die assembly of Claim 25, further comprising: a second bonding element connecting the bond pads of the third die to the terminal pads on the substrate.

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29. The die assembly of Claim 25, further comprising: at least one of an adhesive element disposed between the first die and the second die, and an adhesive element disposed between the second die and the third die.

30. The die assembly of Claim 25, wherein the third die has at least one of a length and a width greater than the second die.

31. The die assembly of Claim 25, being at least partially encapsulated.

32. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, and an opposing second surface having a recess formed therein; the first die attached to the substrate by an adhesive element disposed within the recess; and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die disposed on the first surface of the first die.

33. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, and an opposing second surface having a recess formed therein; the first die attached to the substrate by an adhesive element

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disposed within the recess; and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; the second surface comprising a recessed edge along the perimeter; and the second die disposed on the first surface of the first die whereby the recessed edge provides sufficient clearance for the first bonding element extending from the first die.

34. The die assembly of Claim 33, wherein the adhesive element disposed within the recess comprises one of a die attach adhesive, and a tape adhesive.

35. The die assembly of Claim 33, further comprising: a second adhesive element disposed between the first die and the second die.

36. The die assembly of Claim 33, further comprising: a second bonding element connecting the bond pads of the second die to the terminal pads on the substrate.

37. The die assembly of Claim 33, wherein the second die has at least one of a length and a width greater than the first die.

38. The die assembly of Claim 33, being at least partially encapsulated.

39. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die comprising a first surface disposed on the first surface of the substrate, and an opposing second surface; and

a second die comprising a first surface having a plurality of bond pads located thereon, and a second surface having a recess formed therein; the first die at least partially disposed in the recess of the second die.

40. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die comprising a first surface disposed on the first surface of the substrate in a flip chip attachment, and an opposing second surface; and

a second die comprising a first surface having a plurality of bond pads located thereon, and a second surface having a recess formed therein, the first die at least partially disposed in the recess of the second die.

41. The die assembly of Claim 40, wherein the recess is substantially square or rectangular shaped.

42. The die assembly of Claim 40, wherein the recess is substantially oval or circular shaped.

43. The die assembly of Claim 40, further comprising an adhesive element disposed within the recess between the first and second dies.

44. The die assembly of Claim 43, wherein the adhesive element comprises one of a die attach adhesive and a tape adhesive.

45. The die assembly of Claim 40, further comprising: a bonding element connecting the bond pads of the second die to the terminal pads on the substrate.

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46. The die assembly of Claim 45, being at least partially encapsulated.
47. A semiconductor die package, comprising the die assembly of Claim 1, further comprising a second bonding element connecting the bond pads of the second die to the terminal pads on the substrate, and being at least partially encapsulated.
48. The package of Claim 47, further comprising: a plurality of external contacts disposed on the second surface of the substrate.
49. The package of Claim 48, wherein the external contacts comprise a conductive solder, conductive epoxy, or conductor-filled epoxy.
50. The package of Claim 48, wherein the external contacts are in the form of balls, columns, pins, or a combination thereof.
51. A semiconductor die package, comprising the die assembly of Claim 15, being at least partially encapsulated.
52. A semiconductor die package, comprising the die assembly of Claim 24, further comprising a second bonding element connecting the bond pads of the third die to the terminal pads on the substrate, and being at least partially encapsulated.
53. A semiconductor die package, comprising the die assembly of Claim 32, being at least partially encapsulated.
54. A semiconductor die package, comprising the die assembly of Claim 39, further comprising a bonding element connecting the bond pads of the second die to the terminal pads on the substrate, and being at least partially encapsulated.

55. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface having a plurality of bond pads located thereon, and a second surface; the second die comprising a first surface, a second surface, and a perimeter, the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge along the perimeter of the die;
mounting the first die on the first surface of the substrate;
connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and
mounting the second die on the first die with the bond pads on the first die located within the recessed edge; the recessed edge having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.
56. The method of Claim 55, further comprising, prior to the mounting steps, the step of applying an adhesive element to at least one of the second surface of the first die and the first surface of the substrate, and at least one of the first surface of the first die and the second surface of the second die.
57. The method of Claim 56, wherein the adhesive element comprises a die-attach adhesive, a tape adhesive, or a combination thereof.
58. The method of Claim 56, wherein the adhesive element comprises a die-attach adhesive and is applied by one of screen printing, roller applicator, spray, and transfer.
59. The method of Claim 55, wherein at least one of the substrate, the first die, and the second die, are provided in a pre-taped form with an adhesive tape attached thereto.

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60. The method of Claim 55, wherein the step of connecting the bond pads of the first die is by one of thermosonic bonding, ultrasonic bonding, and tape automated bonding.
61. The method of Claim 55, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a second bonding element.
62. The method of Claim 61, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.
63. The method of Claim 62, wherein the step of encapsulating is by at least one of spin-coating, glob-top, pot molding, and transfer molding.
64. The method of Claim 62, further comprising: mounting a plurality of external contacts on the second surface of the substrate.
65. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
mounting a first die on the first surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, and a second surface;
connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element;
providing a second die comprising a first surface having a plurality of bond pads located thereon, a second surface, a perimeter, and a thickness;
removing a portion of the thickness from the second surface of the second die along the perimeter to form a recessed edge portion;
mounting the second die on the first die with the bond pads on the first die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.

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66. The method of Claim 65, wherein the step of removing the thickness of the second die is performed using one of a chemical wet etch, dry etch, and laser ablation.
67. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface, and a second surface comprising a recess formed therein, the recess having a surface; and the second die comprising a first surface having a plurality of bond pads located thereon, and a second surface;
mounting the first die on the substrate; and
mounting the second die in the recess of the first die with the bond pads exposed.
68. The method of Claim 67, wherein the step of mounting the first die is through a flip chip attachment.
69. The method of Claim 67, wherein the step of mounting the second die comprises applying an adhesive element to at least one of the second surface of the second die and the surface of the recess.
70. The method of Claim 69, wherein the adhesive element comprises a die-attach adhesive, a tape adhesive, or a combination thereof.
71. The method of Claim 67, wherein at least one of the first die and the second die are provided in a pre-taped form with an adhesive tape attached to the surface of the recess, the second surface of the second die, or both.
72. The method of Claim 67, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.

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73. The method of Claim 72, wherein the step of connecting the bond pads of the second die is by one of thermosonic bonding, ultrasonic bonding, and tape automated bonding.
74. The method of Claim 67, further comprising the steps of:
providing a third die comprising a first surface, a second surface, and a perimeter; the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge portion along the perimeter of the die; and
mounting the third die on the first surface of the second die with the bond pads on the second die located within the recessed edge portion of the third die; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.
75. The method of Claim 72, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.
76. The method of Claim 75, further comprising: mounting a plurality of external contacts on the second surface of the substrate.
77. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
providing a first die comprising an active surface, a second surface, and a thickness;
removing a portion of the thickness of the first die from the second surface to form a recess having a surface;
mounting the active surface of the first die on the first surface of the substrate through a flip chip attachment; and

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mounting a second die in the recess of the first die; the second die comprising an active surface having a plurality of bond pads located thereon, and a second surface disposed on the surface of the recess.

78. The method of Claim 77, wherein the step of removing the thickness of the first die is performed using one of a chemical wet etch, dry etch, mechanical drilling, punching, and laser ablation.

79. The method of Claim 77, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.

80. The method of Claim 77, further comprising the steps of:
providing a third die comprising a first surface, a second surface, and a perimeter; the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge portion along the perimeter of the die; and
mounting the third die on the second die with the bond pads on the second die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.

81. The method of Claim 77, further comprising the steps of:
providing a third die comprising an active surface having a plurality of bond pads located thereon, a second surface, a perimeter, and a thickness;
removing a portion of the thickness of the third die from the second surface and along the perimeter to form a recessed edge portion; and
mounting the third die on the second die with the bond pads on the second die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.

82. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, a second die, and a third die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface, and a second surface comprising a recess having a surface; the second die comprising a first surface having a plurality of bond pads located thereon, and a second surface; the third die comprising a first surface, a second surface, and a perimeter, the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge portion along the perimeter of the die;
mounting the first die on the first surface of the substrate;
mounting the second die in the recess of the first die with the bond pads exposed;
connecting the bond pads of the second die to the terminal pads on the substrate with a first bonding element; and
mounting the third die on the second die with the bond pads on the second die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.
83. The method of Claim 82, wherein the step of mounting the first die is through a flip chip attachment.
84. The method of Claim 82, further comprising: connecting the bond pads of the third die to the terminal pads on the substrate with a second bonding element.
85. The method of Claim 84, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.
86. The method of Claim 85, further comprising: mounting a plurality of external contacts on the second surface of the substrate.

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87. A method of fabricating a semiconductor device, comprising the steps of:
- providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
 - providing a first die comprising an active surface, a second surface, and a thickness;
 - removing a portion of the thickness of the first die from the second surface to form a recess having a surface;
 - mounting the active surface of the first die on the first surface of the substrate;
 - mounting a second die in the recess of the first die; the second die comprising an active surface having a plurality of bond pads located thereon, and a second surface;
 - connecting the bond pads of the second die to the terminal pads on the substrate with a first bonding element; and
 - providing a third die comprising an active surface having a plurality of bond pads located thereon, a second surface, a perimeter, and a thickness;
 - removing a portion of the thickness of the third die from the second surface and along the perimeter to form a recessed edge portion; and
 - mounting the third die on the active surface of the second die with the bond pads on the second die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.
88. The method of Claim 87, wherein the steps of removing the thickness of the first die and the third die is performed using one of a chemical wet etch, dry etch, mechanical drilling, punching, and laser ablation.
89. The method of Claim 87, further comprising: connecting the bond pads of the third die to the terminal pads on the substrate with a second bonding element.

90. A method of fabricating a semiconductor device, comprising the steps of:
- providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface having a plurality of bond pads located thereon and an opposing second surface having a recess formed therein, the recess having a surface; and the second die comprising a first active surface, a second surface, and a perimeter;
 - attaching an adhesive element to at least one of the first surface of the substrate, and the surface of the recess;
 - mounting the first die on the first surface of the substrate, with the adhesive element disposed within the recess; and
 - connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and
 - mounting the second die on the first surface of the first die.
91. A method of fabricating a semiconductor device, comprising the steps of:
- providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
 - providing a first die comprising an active surface, an opposing second surface, and a thickness;
 - removing a portion of the thickness of the first die from the second surface to form a recess having a surface;
 - attaching an adhesive element to at least one of the first surface of the substrate, and the surface of the recess;
 - mounting the first die on the first surface of the substrate, with the adhesive element disposed within the recess; and
 - connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and
 - mounting a second die on the active surface of the first die.

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92. The method of Claim 91, wherein the step of removing the thickness of the first die is performed using one of a chemical wet etch, dry etch, mechanical drilling, punching, and laser ablation.

93. The method of Claim 91, wherein the adhesive element comprises a die-attach adhesive, a tape adhesive, or a combination thereof.

94. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface having a plurality of bond pads located thereon and an opposing second surface having a recess formed therein, the recess having a surface; and the second die comprising a first surface, a second surface, and a perimeter, the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge portion along the perimeter of the die;

attaching an adhesive element to at least one of the first surface of the substrate, and the surface of the recess;

mounting the first die on the first surface of the substrate, with the adhesive element disposed within the recess; and

connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and

mounting the second die on the first die with the bond pads on the first die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.

95. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;

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providing a first die comprising an active surface, an opposing second surface, and a thickness;

removing a portion of the thickness of the first die from the second surface to form a recess having a surface;

attaching an adhesive element to at least one of the first surface of the substrate, and the surface of the recess;

mounting the first die on the first surface of the substrate, with the adhesive element disposed within the recess; and

connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and

providing a second die comprising an active surface having a plurality of bond pads located thereon, a second surface, a perimeter, and a thickness;

removing a portion of the thickness of the second die from the second surface and along the perimeter to form a recessed edge portion; and

mounting the second die on the first die with the bond pads on the first die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.

96. The method of Claim 95, wherein each of the steps of forming the recess in the first die and forming the recessed edge portion on the second die, comprises one of a chemical wet etch, dry etch, and laser ablation.

97. The method of Claim 95, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a second bonding element.

98. The method of Claim 97, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.

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99. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising an active surface, and a second surface; the second die comprising an active surface having a plurality of bond pads located thereon, and a second surface having a recess formed therein, the recess having a surface;
mounting the first die on the first surface of the substrate; and
mounting the second die on the first die whereby the first die is at least partially received within the recess of the second die.
100. The method of Claim 99, wherein the step of mounting the second die comprises applying an adhesive element to at least one of the first surface of the first die, and the surface of the recess of the second die.
101. The method of Claim 99, wherein the step of mounting the first die is through a flip chip attachment.
102. The method of Claim 99, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.
103. The method of Claim 102, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.
104. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
mounting a first die on the first surface of the substrate, the first die comprising an active surface and an opposing second surface;

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providing a second die comprising an active surface, an opposing second surface, and a thickness;

removing a portion of the thickness of the second die from the second surface to form a recess having a surface;

mounting the second die on the first die whereby the first die is at least partially received within the recess of the second die.

105. The method of Claim 104, wherein the step of mounting the first die is through a flip chip attachment.

106. The method of Claim 104, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.

107. The method of Claim 104, further comprising, prior to mounting the second die, attaching an adhesive element to at least one of the surface of the recess, and the surface of the first die.

108. The method of Claim 104, wherein the step of removing the thickness of the second die comprises one of a chemical wet etch, dry etch, mechanical drilling, punching, and laser ablation.

109. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
providing a first die comprising an active surface and an opposing second surface;
mounting the active surface of the first die on the first surface of the substrate through a flip chip attachment;
providing a second die comprising an active surface, an opposing second surface, and a thickness;

WHAT IS CLAIMED IS:

1. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface having a plurality of bond pads located thereon, a second surface, and a first bonding element connecting the bond pads to the terminal pads on the substrate; and

a second die comprising a first surface, a second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; the second surface comprising a recessed edge portion along the perimeter of the die; the second die disposed on the first surface of the first die with the bond pads on the first die positioned within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.

2. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate; the first die comprising an active surface having a plurality of bond pads located thereon, an opposing inactive surface, and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die comprising an active surface, an opposing inactive surface, and a perimeter; the active surface having a plurality of bond pads located thereon; the inactive surface having a recessed edge portion along the perimeter of the die; the second die disposed on the active surface of the first die with the recessed edge portion providing an opening over the bond pads of the first die, the opening sufficient for passage of the first bonding element therethrough.

3. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a surface having terminal pads located thereon;

a first die disposed on said surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, a second surface, and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; the second surface having a thickness removed along the perimeter of the die to provide a recessed edge portion; the second die disposed on the first surface of the first die with the bond pads of the first die located within the recessed edge portion; the recessed edge portion having a sufficient height for clearance of the first bonding element extending from the bond pads on the first die.

4. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a surface having a plurality of terminal pads located thereon;

a first die disposed on said surface of the substrate; the first die comprising a first side having a plurality of bond pads located thereon, an opposing second side, and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die comprising a first side, an opposing second side, and a perimeter; the first side having a plurality of bond pads located thereon; the second side comprising a recessed edge portion along the perimeter of the die; the second die disposed on the first side of the first die with the bond pads of the first die located within the recessed edge portion of the second die, the recessed edge portion having a height sufficient for passage of the first bonding element from the bond pads of the first die therethrough.

5. The die assembly of Claim 4, further comprising: a second bonding element connecting the bond pads of the second die to the terminal pads on the substrate.

6. The die assembly of Claim 4, further comprising: at least one of an adhesive element disposed between the first die and the substrate, and an adhesive element disposed between the second die and the first die.
7. The die assembly of Claim 6, wherein the adhesive element comprises a die attach adhesive.
8. The die assembly of Claim 6, wherein the adhesive element comprises a tape adhesive.
9. The die assembly of Claim 4, wherein the second die has at least one of a length and a width greater than the first die.
10. The die assembly of Claim 4, wherein the bonding element comprises a TAB tape.
11. The die assembly of Claim 4, wherein the bonding element comprises a wire bond.
12. The die assembly of Claim 4, wherein the substrate comprises a material selected from the group consisting of bismaleimide triazine resin, epoxy resins, ceramics, and polyimide resins.
13. The die assembly of Claim 4, wherein the substrate comprises a metal leadframe.
14. The die assembly of Claim 4, being at least partially encapsulated.
15. A stacked die assembly, comprising:
at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having a plurality of terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein; and

a second die at least partially disposed within the recess of the first die.

16. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having a plurality of terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate through a flip chip attachment, and comprising a first surface and a second surface comprising a recess; and

a second die at least partially disposed within the recess of the first die.

17. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having a plurality of terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate through a flip chip attachment, and comprising a first surface and a second surface comprising a recess; and

a second die at least partially disposed within the recess of the first die; the second die comprising a first side having a plurality of bond pads located thereon; and an opposing second side disposed on the first die.

18. The die assembly of Claim 17, further comprising: a bonding element connecting the bond pads of the second die to the terminal pads on the substrate.

19. The die assembly of Claim 18, wherein the bonding element comprises one of a wire bond and a TAB tape.

20. The die assembly of Claim 17, further comprising: an adhesive element disposed within the recess between the second die and the first die.
21. The die assembly of Claim 17, wherein the adhesive element comprises one of a die attach adhesive, and a tape adhesive.
22. The die assembly of Claim 17, being at least partially encapsulated.
23. A stacked die assembly, comprising:
a plurality of semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;
a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein; and
a second die at least partially disposed in the recess of the first die; and
a third die disposed on the second die.
24. A stacked die assembly, comprising:
a plurality of semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;
a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein; and
a second die at least partially disposed in the recess of the first die, and comprising a first surface having a plurality of bond pads located thereon, an opposing second surface disposed on the first die, and a bonding element connecting the bond pads of the second die to the terminal pads on the substrate; and
a third die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; and the second surface

comprising a recessed edge portion along the perimeter; the second surface of the third die disposed on the first surface of the second die whereby the recessed edge portion provides sufficient clearance for the first bonding element extending from the bond pads of the second die.

25. A stacked die assembly, comprising:

a plurality of semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die comprising a first surface disposed on the first surface of the substrate in a flip chip attachment, and a second surface having a recess, the recess having a surface; and

a second die at least partially disposed in the recess of the first die, and comprising a first surface having a plurality of bond pads located thereon, an opposing second surface disposed on the surface of the recess, and a first bonding element connecting the bond pads of the second die to the terminal pads on the substrate; and

a third die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; and the second surface comprising a recessed edge portion along the perimeter; the second surface disposed on the first surface of the second die whereby the recessed edge portion provides sufficient clearance for the first bonding element extending from the bond pads of the second die.

26. The die assembly of Claim 25, wherein the recess in the first die is substantially square or rectangular shaped.

27. The die assembly of Claim 25, wherein the recess in the first die is substantially oval or circular shaped.

28. The die assembly of Claim 25, further comprising: a second bonding element connecting the bond pads of the third die to the terminal pads on the substrate.

29. The die assembly of Claim 25, further comprising: at least one of an adhesive element disposed between the first die and the second die, and an adhesive element disposed between the second die and the third die.
30. The die assembly of Claim 25, wherein the third die has at least one of a length and a width greater than the second die.
31. The die assembly of Claim 25, being at least partially encapsulated.
32. A stacked die assembly, comprising:
at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;
a first die disposed on the first surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, and an opposing second surface having a recess formed therein; the first die attached to the substrate by an adhesive element disposed within the recess; and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and
a second die disposed on the first surface of the first die.
33. A stacked die assembly, comprising:
at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;
a first die disposed on the first surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, and an opposing second surface having a recess formed therein; the first die attached to the substrate by an adhesive element

disposed within the recess; and a first bonding element connecting the bond pads of the first die to the terminal pads on the substrate; and

a second die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; the second surface comprising a recessed edge along the perimeter; and the second die disposed on the first surface of the first die whereby the recessed edge provides sufficient clearance for the first bonding element extending from the first die.

34. The die assembly of Claim 33, wherein the adhesive element disposed within the recess comprises one of a die attach adhesive, and a tape adhesive.

35. The die assembly of Claim 33, further comprising: a second adhesive element disposed between the first die and the second die.

36. The die assembly of Claim 33, further comprising: a second bonding element connecting the bond pads of the second die to the terminal pads on the substrate.

37. The die assembly of Claim 33, wherein the second die has at least one of a length and a width greater than the first die.

38. The die assembly of Claim 33, being at least partially encapsulated.

39. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die comprising a first surface disposed on the first surface of the substrate, and an opposing second surface; and

a second die comprising a first surface having a plurality of bond pads located thereon, and a second surface having a recess formed therein; the first die at least partially disposed in the recess of the second die.

40. A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die comprising a first surface disposed on the first surface of the substrate in a flip chip attachment, and an opposing second surface; and

a second die comprising a first surface having a plurality of bond pads located thereon, and a second surface having a recess formed therein, the first die at least partially disposed in the recess of the second die.

41. The die assembly of Claim 40, wherein the recess is substantially square or rectangular shaped.

42. The die assembly of Claim 40, wherein the recess is substantially oval or circular shaped.

43. The die assembly of Claim 40, further comprising an adhesive element disposed within the recess between the first and second dies.

44. The die assembly of Claim 43, wherein the adhesive element comprises one of a die attach adhesive and a tape adhesive.

45. The die assembly of Claim 40, further comprising: a bonding element connecting the bond pads of the second die to the terminal pads on the substrate.

- 46. The die assembly of Claim 45, being at least partially encapsulated.
- 47. A semiconductor die package, comprising the die assembly of Claim 1, further comprising a second bonding element connecting the bond pads of the second die to the terminal pads on the substrate, and being at least partially encapsulated.
- 48. The package of Claim 47, further comprising: a plurality of external contacts disposed on the second surface of the substrate.
- 49. The package of Claim 48, wherein the external contacts comprise a conductive solder, conductive epoxy, or conductor-filled epoxy.
- 50. The package of Claim 48, wherein the external contacts are in the form of balls, columns, pins, or a combination thereof.
- 51. A semiconductor die package, comprising the die assembly of Claim 15, being at least partially encapsulated.
- 52. A semiconductor die package, comprising the die assembly of Claim 24, further comprising a second bonding element connecting the bond pads of the third die to the terminal pads on the substrate, and being at least partially encapsulated.
- 53. A semiconductor die package, comprising the die assembly of Claim 32, being at least partially encapsulated.
- 54. A semiconductor die package, comprising the die assembly of Claim 39, further comprising a bonding element connecting the bond pads of the second die to the terminal pads on the substrate, and being at least partially encapsulated.

55. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface having a plurality of bond pads located thereon, and a second surface; the second die comprising a first surface, a second surface, and a perimeter, the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge along the perimeter of the die;
mounting the first die on the first surface of the substrate;
connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and
mounting the second die on the first die with the bond pads on the first die located within the recessed edge; the recessed edge having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.
56. The method of Claim 55, further comprising, prior to the mounting steps, the step of applying an adhesive element to at least one of the second surface of the first die and the first surface of the substrate, and at least one of the first surface of the first die and the second surface of the second die.
57. The method of Claim 56, wherein the adhesive element comprises a die-attach adhesive, a tape adhesive, or a combination thereof.
58. The method of Claim 56, wherein the adhesive element comprises a die-attach adhesive and is applied by one of screen printing, roller applicator, spray, and transfer.
59. The method of Claim 55, wherein at least one of the substrate, the first die, and the second die, are provided in a pre-taped form with an adhesive tape attached thereto.

60. The method of Claim 55, wherein the step of connecting the bond pads of the first die is by one of thermosonic bonding, ultrasonic bonding, and tape automated bonding.
61. The method of Claim 55, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a second bonding element.
62. The method of Claim 61, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.
63. The method of Claim 62, wherein the step of encapsulating is by at least one of spin-coating, glob-top, pot molding, and transfer molding.
64. The method of Claim 62, further comprising: mounting a plurality of external contacts on the second surface of the substrate.
65. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
mounting a first die on the first surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, and a second surface;
connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element;
providing a second die comprising a first surface having a plurality of bond pads located thereon, a second surface, a perimeter, and a thickness;
removing a portion of the thickness from the second surface of the second die along the perimeter to form a recessed edge portion;
mounting the second die on the first die with the bond pads on the first die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.

66. The method of Claim 65, wherein the step of removing the thickness of the second die is performed using one of a chemical wet etch, dry etch, and laser ablation.
67. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface, and a second surface comprising a recess formed therein, the recess having a surface; and the second die comprising a first surface having a plurality of bond pads located thereon, and a second surface;
mounting the first die on the substrate; and
mounting the second die in the recess of the first die with the bond pads exposed.
68. The method of Claim 67, wherein the step of mounting the first die is through a flip chip attachment.
69. The method of Claim 67, wherein the step of mounting the second die comprises applying an adhesive element to at least one of the second surface of the second die and the surface of the recess.
70. The method of Claim 69, wherein the adhesive element comprises a die-attach adhesive, a tape adhesive, or a combination thereof.
71. The method of Claim 67, wherein at least one of the first die and the second die are provided in a pre-taped form with an adhesive tape attached to the surface of the recess, the second surface of the second die, or both.
72. The method of Claim 67, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.

73. The method of Claim 72, wherein the step of connecting the bond pads of the second die is by one of thermosonic bonding, ultrasonic bonding, and tape automated bonding.

74. The method of Claim 67, further comprising the steps of:

providing a third die comprising a first surface, a second surface, and a perimeter; the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge portion along the perimeter of the die; and

mounting the third die on the first surface of the second die with the bond pads on the second die located within the recessed edge portion of the third die; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.

75. The method of Claim 72, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.

76. The method of Claim 75, further comprising: mounting a plurality of external contacts on the second surface of the substrate.

77. A method of fabricating a semiconductor device, comprising the steps of:

providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;

providing a first die comprising an active surface, a second surface, and a thickness;

removing a portion of the thickness of the first die from the second surface to form a recess having a surface;

mounting the active surface of the first die on the first surface of the substrate through a flip chip attachment; and

mounting a second die in the recess of the first die; the second die comprising an active surface having a plurality of bond pads located thereon, and a second surface disposed on the surface of the recess.

78. The method of Claim 77, wherein the step of removing the thickness of the first die is performed using one of a chemical wet etch, dry etch, mechanical drilling, punching, and laser ablation.

79. The method of Claim 77, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.

80. The method of Claim 77, further comprising the steps of:
providing a third die comprising a first surface, a second surface, and a perimeter; the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge portion along the perimeter of the die; and
mounting the third die on the second die with the bond pads on the second die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.

81. The method of Claim 77, further comprising the steps of:
providing a third die comprising an active surface having a plurality of bond pads located thereon, a second surface, a perimeter, and a thickness;
removing a portion of the thickness of the third die from the second surface and along the perimeter to form a recessed edge portion; and
mounting the third die on the second die with the bond pads on the second die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.

82. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, a second die, and a third die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface, and a second surface comprising a recess having a surface; the second die comprising a first surface having a plurality of bond pads located thereon, and a second surface; the third die comprising a first surface, a second surface, and a perimeter, the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge portion along the perimeter of the die;
mounting the first die on the first surface of the substrate;
mounting the second die in the recess of the first die with the bond pads exposed;
connecting the bond pads of the second die to the terminal pads on the substrate with a first bonding element; and
mounting the third die on the second die with the bond pads on the second die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.
83. The method of Claim 82, wherein the step of mounting the first die is through a flip chip attachment.
84. The method of Claim 82, further comprising: connecting the bond pads of the third die to the terminal pads on the substrate with a second bonding element.
85. The method of Claim 84, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.
86. The method of Claim 85, further comprising: mounting a plurality of external contacts on the second surface of the substrate.

87. A method of fabricating a semiconductor device, comprising the steps of:
- providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
 - providing a first die comprising an active surface, a second surface, and a thickness;
 - removing a portion of the thickness of the first die from the second surface to form a recess having a surface;
 - mounting the active surface of the first die on the first surface of the substrate;
 - mounting a second die in the recess of the first die; the second die comprising an active surface having a plurality of bond pads located thereon, and a second surface;
 - connecting the bond pads of the second die to the terminal pads on the substrate with a first bonding element; and
 - providing a third die comprising an active surface having a plurality of bond pads located thereon, a second surface, a perimeter, and a thickness;
 - removing a portion of the thickness of the third die from the second surface and along the perimeter to form a recessed edge portion; and
 - mounting the third die on the active surface of the second die with the bond pads on the second die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the second die.
88. The method of Claim 87, wherein the steps of removing the thickness of the first die and the third die is performed using one of a chemical wet etch, dry etch, mechanical drilling, punching, and laser ablation.
89. The method of Claim 87, further comprising: connecting the bond pads of the third die to the terminal pads on the substrate with a second bonding element.

90. A method of fabricating a semiconductor device, comprising the steps of:
- providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface having a plurality of bond pads located thereon and an opposing second surface having a recess formed therein, the recess having a surface; and the second die comprising a first active surface, a second surface, and a perimeter;
 - attaching an adhesive element to at least one of the first surface of the substrate, and the surface of the recess;
 - mounting the first die on the first surface of the substrate, with the adhesive element disposed within the recess; and
 - connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and
 - mounting the second die on the first surface of the first die.
91. A method of fabricating a semiconductor device, comprising the steps of:
- providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
 - providing a first die comprising an active surface, an opposing second surface, and a thickness;
 - removing a portion of the thickness of the first die from the second surface to form a recess having a surface;
 - attaching an adhesive element to at least one of the first surface of the substrate, and the surface of the recess;
 - mounting the first die on the first surface of the substrate, with the adhesive element disposed within the recess; and
 - connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and
 - mounting a second die on the active surface of the first die.

92. The method of Claim 91, wherein the step of removing the thickness of the first die is performed using one of a chemical wet etch, dry etch, mechanical drilling, punching, and laser ablation.

93. The method of Claim 91, wherein the adhesive element comprises a die-attach adhesive, a tape adhesive, or a combination thereof.

94. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising a first surface having a plurality of bond pads located thereon and an opposing second surface having a recess formed therein, the recess having a surface; and the second die comprising a first surface, a second surface, and a perimeter, the first surface having a plurality of bond pads located thereon, and the second surface comprising a recessed edge portion along the perimeter of the die;

attaching an adhesive element to at least one of the first surface of the substrate, and the surface of the recess;

mounting the first die on the first surface of the substrate, with the adhesive element disposed within the recess; and

connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and

mounting the second die on the first die with the bond pads on the first die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.

95. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;

providing a first die comprising an active surface, an opposing second surface, and a thickness;

removing a portion of the thickness of the first die from the second surface to form a recess having a surface;

attaching an adhesive element to at least one of the first surface of the substrate, and the surface of the recess;

mounting the first die on the first surface of the substrate, with the adhesive element disposed within the recess; and

connecting the bond pads of the first die to the terminal pads on the substrate with a first bonding element; and

providing a second die comprising an active surface having a plurality of bond pads located thereon, a second surface, a perimeter, and a thickness;

removing a portion of the thickness of the second die from the second surface and along the perimeter to form a recessed edge portion; and

mounting the second die on the first die with the bond pads on the first die located within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die.

96. The method of Claim 95, wherein each of the steps of forming the recess in the first die and forming the recessed edge portion on the second die, comprises one of a chemical wet etch, dry etch, and laser ablation.

97. The method of Claim 95, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a second bonding element.

98. The method of Claim 97, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.

99. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate, a first die, and a second die; the substrate comprising a first surface having terminal pads located thereon, and a second surface; the first die comprising an active surface, and a second surface; the second die comprising an active surface having a plurality of bond pads located thereon, and a second surface having a recess formed therein, the recess having a surface;
mounting the first die on the first surface of the substrate; and
mounting the second die on the first die whereby the first die is at least partially received within the recess of the second die.
100. The method of Claim 99, wherein the step of mounting the second die comprises applying an adhesive element to at least one of the first surface of the first die, and the surface of the recess of the second die.
101. The method of Claim 99, wherein the step of mounting the first die is through a flip chip attachment.
102. The method of Claim 99, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.
103. The method of Claim 102, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.
104. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
mounting a first die on the first surface of the substrate, the first die comprising an active surface and an opposing second surface;

providing a second die comprising an active surface, an opposing second surface, and a thickness;

removing a portion of the thickness of the second die from the second surface to form a recess having a surface;

mounting the second die on the first die whereby the first die is at least partially received within the recess of the second die.

105. The method of Claim 104, wherein the step of mounting the first die is through a flip chip attachment.

106. The method of Claim 104, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.

107. The method of Claim 104, further comprising, prior to mounting the second die, attaching an adhesive element to at least one of the surface of the recess, and the surface of the first die.

108. The method of Claim 104, wherein the step of removing the thickness of the second die comprises one of a chemical wet etch, dry etch, mechanical drilling, punching, and laser ablation.

109. A method of fabricating a semiconductor device, comprising the steps of:
providing a substrate comprising a first surface having terminal pads located thereon, and a second surface;
providing a first die comprising an active surface and an opposing second surface;
mounting the active surface of the first die on the first surface of the substrate through a flip chip attachment;
providing a second die comprising an active surface, an opposing second surface, and a thickness;

removing a portion of the thickness of the second die from the second surface to form a recess having a surface;

attaching an adhesive element to at least one of the surface of the recess, and the second surface of the first die; and

mounting the second die on the first die whereby the first die is at least partially received within the recess of the second die.

110. The method of Claim 109, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.

111. The method of Claim 110, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.

112. (new) A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface having a plurality of bond pads located thereon, a second surface, and a first bonding element connecting the bond pads to the terminal pads on the substrate; and

a second die comprising a first surface, a second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; the second surface comprising a recessed edge portion along the perimeter of the die; the second die disposed on the first surface of the first die with the bond pads on the first die positioned within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die;

means for mounting the first die on the substrate;

means for mounting the second die on the first die; and

means for connecting the bond pads of the first die to the terminal pads on the substrate.

113. (new) The assembly of Claim 112, wherein the mounting means comprises a die-attach adhesive, a tape adhesive, or a combination thereof.

114. (new) The assembly of Claim 112, wherein the connecting means comprises a wire bond.

115. (new) The assembly of Claim 112, wherein the connecting means comprises a TAB tape.

116. (new) The assembly of Claim 112, further comprising means for connecting the assembly to an external electrical apparatus.

117. (new) The assembly of Claim 116, wherein the assembly connecting means comprises a conductive solder, conductive epoxy, or conductor-filled epoxy, attached to the second surface of the substrate.

118. (new) The assembly of Claim 116, wherein the assembly connecting means are in the form of balls, columns, pins, or a combination thereof, attached to the second surface of the substrate.

119. (new) The assembly of Claim 112, being at least partially encapsulated to form a die package.

120. (new) A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having a plurality of terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein;

a second die comprising a first side having a plurality of bond pads located thereon, and an opposing second side at least partially disposed within the recess of the first die;

means for mounting the first die on the substrate;

means for mounting the second die in the recess of the first die; and

means for connecting the bond pads of the second die to the terminal pads on the substrate.

121. (new) The assembly of Claim 120, wherein the mounting means of the first die comprises a flip chip attachment.

122. (new) The assembly of Claim 120, further comprising means for connecting the assembly to an external electrical apparatus.

123. (new) The assembly of Claim 120, being at least partially encapsulated to form a die package.

124. (new) A stacked die assembly, comprising:

a plurality of semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein; and

a second die at least partially disposed in the recess of the first die, and comprising a first surface having a plurality of bond pads located thereon, an opposing second surface disposed on the first die; and

a third die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; and the second surface comprising a recessed edge portion along the perimeter; the second surface of the third die disposed on the first surface of the second die;

means for mounting the first die on the substrate;

means for mounting the second die in the recess of the first die;

means for mounting the third die on the second die; and

means for connecting the bond pads of the second and third dies to the terminal pads on the substrate.

whereby the recessed edge portion of the third die provides sufficient clearance for the connecting means extending from the bond pads of the second die to the substrate.

125. (new) The assembly of Claim 124, wherein the mounting means of the first die comprises a flip chip attachment.

126. (new) The assembly of Claim 124, further comprising means for connecting the assembly to an external electrical apparatus.

127. (new) The assembly of Claim 124, being at least partially encapsulated to form a die package.

128. (new) A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, and an opposing second surface having a recess formed therein;

a second die disposed on the first surface of the first die.

means for mounting the first die on the substrate, the mounting means disposed within the recess;

means for mounting the second die on the first die; and

means for connecting the bond pads of the first die to the terminal pads on the substrate.

129. (new) The assembly of Claim 128, wherein the mounting means of the first and second dies comprises a die-attach adhesive, a tape adhesive, or a combination thereof.

130. (new) The assembly of Claim 128, further comprising means for connecting the assembly to an external electrical apparatus.

131. (new) The assembly of Claim 128, being at least partially encapsulated to form a die package.

132. (new) A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die comprising a first surface disposed on the first surface of the substrate, and an opposing second surface; and

a second die comprising a first surface having a plurality of bond pads located thereon, and a second surface having a recess formed therein; the first die at least partially disposed in the recess of the second die;

means for mounting the first die on the substrate;

means for mounting the first die in the recess of the second die; and
means for connecting the bond pads of the second die to the terminal pads on the
substrate.

133. (new) The assembly of Claim 132, wherein the mounting means of the first die to the
substrate comprises a flip chip attachment.

134. (new) The assembly of Claim 132, wherein the mounting means of the first die to the
second die comprises an adhesive element disposed within the recess between the first and
second dies.

135. (new) The assembly of Claim 134, wherein the adhesive element comprises one of a die
attach adhesive and a tape adhesive.

136. (new) The assembly of Claim 132, being at least partially encapsulated to form a die
package.

137. (new) An apparatus, comprising:
an electrical apparatus; and
the die package of Claim 119 in electrical communication with the electrical
apparatus.

138. (new) The apparatus of Claim 137, wherein the electrical apparatus is selected from the
group consisting of a PCB, motherboard, program logic controller, and testing apparatus.

139. (new) An apparatus, comprising:
an electrical apparatus; and
the die package of Claim 119 in electrical communication with the electrical
apparatus.

140. (new) An apparatus, comprising:

an electrical apparatus; and

the die package of Claim 123 in electrical communication with the electrical apparatus.

141. (new) An apparatus, comprising:

an electrical apparatus; and

the die package of Claim 127 in electrical communication with the electrical apparatus.

142. (new) An apparatus, comprising:

an electrical apparatus; and

the die package of Claim 131 in electrical communication with the electrical apparatus.

143. (new) An apparatus, comprising:

an electrical apparatus; and

the die package of Claim 136 in electrical communication with the electrical apparatus.

144. (new) A panel substrate, comprising multiple die assemblies according to Claim 1.

145. (new) A panel substrate, comprising multiple die assemblies according to Claim 15.

146. (new) A panel substrate, comprising multiple die assemblies according to Claim 24.

147. (new) A panel substrate, comprising multiple die assemblies according to Claim 32.

Blacklined Claims

148. (new) A panel substrate, comprising multiple die assemblies according to Claim 39.

Replacement Claims

removing a portion of the thickness of the second die from the second surface to form a recess having a surface;

attaching an adhesive element to at least one of the surface of the recess, and the second surface of the first die; and

mounting the second die on the first die whereby the first die is at least partially received within the recess of the second die.

110. The method of Claim 109, further comprising: connecting the bond pads of the second die to the terminal pads on the substrate with a bonding element.

111. The method of Claim 110, further comprising: the step of encapsulating at least a portion of the semiconductor device to form a package.

112. (new) A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface having a plurality of bond pads located thereon, a second surface, and a first bonding element connecting the bond pads to the terminal pads on the substrate; and

A' a second die comprising a first surface, a second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; the second surface comprising a recessed edge portion along the perimeter of the die; the second die disposed on the first surface of the first die with the bond pads on the first die positioned within the recessed edge portion; the recessed edge portion having a height sufficient for clearance of the first bonding element extending from the bond pads of the first die;

means for mounting the first die on the substrate;

means for mounting the second die on the first die; and

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means for connecting the bond pads of the first die to the terminal pads on the substrate.

113. (new) The assembly of Claim 112, wherein the mounting means comprises a die-attach adhesive, a tape adhesive, or a combination thereof.

114. (new) The assembly of Claim 112, wherein the connecting means comprises a wire bond.

115. (new) The assembly of Claim 112, wherein the connecting means comprises a TAB tape.

116. (new) The assembly of Claim 112, further comprising means for connecting the assembly to an external electrical apparatus.

117. (new) The assembly of Claim 116, wherein the assembly connecting means comprises a conductive solder, conductive epoxy, or conductor-filled epoxy, attached to the second surface of the substrate.

118. (new) The assembly of Claim 116, wherein the assembly connecting means are in the form of balls, columns, pins, or a combination thereof, attached to the second surface of the substrate.

119. (new) The assembly of Claim 112, being at least partially encapsulated to form a die package.

A' cond.

Replacement Claims

120. (new) A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having a plurality of terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein;

a second die comprising a first side having a plurality of bond pads located thereon, and an opposing second side at least partially disposed within the recess of the first die;

means for mounting the first die on the substrate;

means for mounting the second die in the recess of the first die; and

means for connecting the bond pads of the second die to the terminal pads on the substrate.

A' Cont.
121. (new) The assembly of Claim 120, wherein the mounting means of the first die comprises a flip chip attachment.

122. (new) The assembly of Claim 120, further comprising means for connecting the assembly to an external electrical apparatus.

123. (new) The assembly of Claim 120, being at least partially encapsulated to form a die package.

124. (new) A stacked die assembly, comprising:

a plurality of semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die disposed on the first surface of the substrate, and comprising a first surface and a second surface having a recess formed therein; and

Replacement Claims

a second die at least partially disposed in the recess of the first die, and comprising a first surface having a plurality of bond pads located thereon, an opposing second surface disposed on the first die; and

a third die comprising a first surface, an opposing second surface, and a perimeter; the first surface having a plurality of bond pads located thereon; and the second surface comprising a recessed edge portion along the perimeter; the second surface of the third die disposed on the first surface of the second die;

means for mounting the first die on the substrate;

means for mounting the second die in the recess of the first die;

means for mounting the third die on the second die; and

means for connecting the bond pads of the second and third dies to the terminal pads on the substrate.

whereby the recessed edge portion of the third die provides sufficient clearance for the connecting means extending from the bond pads of the second die to the substrate.

125. (new) The assembly of Claim 124, wherein the mounting means of the first die comprises a flip chip attachment.

126. (new) The assembly of Claim 124, further comprising means for connecting the assembly to an external electrical apparatus.

127. (new) The assembly of Claim 124, being at least partially encapsulated to form a die package.

128. (new) A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

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a first die disposed on the first surface of the substrate; the first die comprising a first surface having a plurality of bond pads located thereon, and an opposing second surface having a recess formed therein;

a second die disposed on the first surface of the first die.

means for mounting the first die on the substrate, the mounting means disposed within the recess;

means for mounting the second die on the first die; and

means for connecting the bond pads of the first die to the terminal pads on the substrate.

129. (new) The assembly of Claim 128, wherein the mounting means of the first and second dies comprises a die-attach adhesive, a tape adhesive, or a combination thereof.

130. (new) The assembly of Claim 128, further comprising means for connecting the assembly to an external electrical apparatus.

131. (new) The assembly of Claim 128, being at least partially encapsulated to form a die package.

132. (new) A stacked die assembly, comprising:

at least two semiconductor dies disposed on a substrate in a stacked arrangement; the substrate comprising a first surface having terminal pads located thereon, and a second surface;

a first die comprising a first surface disposed on the first surface of the substrate, and an opposing second surface; and

a second die comprising a first surface having a plurality of bond pads located thereon, and a second surface having a recess formed therein; the first die at least partially disposed in the recess of the second die;

means for mounting the first die on the substrate;

Replacement Claims

means for mounting the first die in the recess of the second die; and
means for connecting the bond pads of the second die to the terminal pads on the substrate.

133. (new) The assembly of Claim 132, wherein the mounting means of the first die to the substrate comprises a flip chip attachment.

134. (new) The assembly of Claim 132, wherein the mounting means of the first die to the second die comprises an adhesive element disposed within the recess between the first and second dies.

135. (new) The assembly of Claim 134, wherein the adhesive element comprises one of a die attach adhesive and a tape adhesive.

A' cont.
136. (new) The assembly of Claim 132, being at least partially encapsulated to form a die package.

137. (new) An apparatus, comprising:
an electrical apparatus; and
the die package of Claim 119 in electrical communication with the electrical apparatus.

138. (new) The apparatus of Claim 137, wherein the electrical apparatus is selected from the group consisting of a PCB, motherboard, program logic controller, and testing apparatus.

139. (new) An apparatus, comprising:
an electrical apparatus; and
the die package of Claim 119 in electrical communication with the electrical apparatus.

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140. (new) An apparatus, comprising:
an electrical apparatus; and
the die package of Claim 123 in electrical communication with the electrical apparatus.
141. (new) An apparatus, comprising:
an electrical apparatus; and
the die package of Claim 127 in electrical communication with the electrical apparatus.
142. (new) An apparatus, comprising:
an electrical apparatus; and
the die package of Claim 131 in electrical communication with the electrical apparatus.
143. (new) An apparatus, comprising:
an electrical apparatus; and
the die package of Claim 136 in electrical communication with the electrical apparatus.
144. (new) A panel substrate, comprising multiple die assemblies according to Claim 1.
145. (new) A panel substrate, comprising multiple die assemblies according to Claim 15.
146. (new) A panel substrate, comprising multiple die assemblies according to Claim 24.
147. (new) A panel substrate, comprising multiple die assemblies according to Claim 32.

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cont.

Replacement Claims

148. (new) A panel substrate, comprising multiple die assemblies according to Claim 39.

A'
cont.
